Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

ENERGY UPDATE 1979

OVERVIEW • CONSERVATION OIL AND NATURAL GAS • ELECTRICITY • REPLACING OIL RENEWABLE ENERGY • COAL • URANIUM AND NUCLEAR ENERGY

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ENERGY UPDATE 1979

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OVERVIEW

THE WORLD SITUATION

Nineteen seventy-nine was a very bad year for oil-importing nations throughout the world. Supplies of oil from Iran were cut off and prices soared again, after a brief respite between 1976 and 1978. Fear of shortages and higher prices led a number of countries to redouble their efforts to slow down the domestic demand for energy and, in the United States, car drivers again had to line up at service stations, as they did in 1973.

The major cause for concern continued to be political turmoil in Iran, prior to 1978 the second largest oil exporter in the world after Saudi Arabia. The revolution in Iran led directly to the complete shutdown of oil exports for two months. While a few other exporting countries increased production to make up the shortfall, there was still a net loss of five per cent in oil supplies available to the world market for part of the year.

An increasing amount of oil sold on a "spot" basis, rather than under contract, and spot prices were frequently far above official prices. This was a symptom of uncoordinated, competitive attempts by many consumers to secure supplies in the face of profound and worrying changes in the world oil supply system.

The rapid rise in world oil prices underlined the growing power of the Organization of Petroleum Exporting Countries (OPEC) cartel. OPEC prices were increased twice during the year, more than doubling.

The world financial system will have to meet the challenge of recycling the OPEC nations' surplus oil revenues, an estimated $110 billion dollars in 1980. Further price increases and the determination by some OPEC members to reduce supplies would not only put a further strain on world financial systems, but could also place serious limitations on economic growth in both industrialized nations and developing countries.

While the Iranian situation and soaring prices were extremely serious problems, they diverted attention from an even more basic issue. Since 1975, oil exploration has been adding to world reserves at an average annual rate of 1.7 billion cubic metres. At the same time, our cars and factories are burning up an estimated 3.2 billion cubic metres of oil per year.

Recently, the Soviet Union warned east European nations that they can no longer expect increased supplies from Russia and must look elsewhere for their oil needs. If this proves to be the case, more countries may become bidders for OPEC supplies, sharply increasing demand and the pressure for higher prices.

Higher prices for oil are translated into higher prices for almost everything else. Food, transportation and industrial products all go up in cost. The increasing cost of imported oil means less capital for investment, less purchasing power for consumers, slower economic growth and strong inflationary pressures.

An acute shortage of oil could be extremely damaging. While it would moderate eventually, because of the effect of higher prices, it could bring on a sudden shift toward self-concern, both within and between industrial nations, sparking a bitter competition for scarce supplies, blocking trade, breeding social conflicts and undermining political stability. Thus, the stakes in the oil-supply game are very high indeed.

Concerned about the availability and the rising cost of oil, member countries of the International Energy Agency (IEA) agreed in March to reduce their combined imports of oil during 1979 by 5 per cent of total consumption, or about 300 000 cubic metres per day, to reduce the pressure on the world market. The reduction was to be achieved by some combination of more efficient use of energy; substitution away from oil in favor of other, less scarce fuels; increased domestic production; greater use of lower-quality crudes; and domestic pricing policies designed to promote conservation.

CANADA

Canada subscribed to the IEA targets. In a subsequent Tokyo Summit Meeting in late June, following announcement of major OPEC price increases, Canada confirmed that it would reduce net oil imports by about 16 000 cubic metres a day - from 40 000 to 24 000 cubic metres a day by the fourth quarter of 1979 - and that it would hold net imports at that reduced level throughout 1980. This commitment was reiterated at a meeting of IEA Ministers in December.

Canada also agreed to longer-term commitments at Tokyo. While recognizing that domestic oil production is forecast to decline through to at least 1985, Canada agreed to hold net oil imports in 1985 to a maximum of 95 000 cubic metres a day, down from an earlier commitment of 127 000 cubic metres a day in that year.

Even allowing for a reduced level of imports, price increases announced by OPEC in June and December 1979, were expected to add more than $700 million to Canada's oil import bill in 1980, raising the total to an estimated $2.4 billion. A higher level of imports in subsequent years, probably at higher prices, will mean a correspondingly higher oil import bill.

In March 1979, in line with IEA commitments and in response to the Iranian situation, Parliament passed the Energy Supplies Emergency Act, 1979. This legislation provides the government with authority to allocate energy resources within Canada during periods of supply disruption caused by shortages.

The authority is of a stand-by nature. A specific decision would be taken by the federal Cabinet and would be submitted to Parliament, to invoke the emergency authority. This move met a commitment to the IEA to have adequate legislative authority to permit the imposition of mandatory rationing and control in the event of an emergency.

By the end of the year, the National Energy Board warned that the outlook for winter oil supplies had become tight. The main cause for the less-than-favorable outlook was an uncertain supply, exacerbated by continued high demand for petroleum products.

At that time, production in Alberta, through to March 1980, was forecast to be 3 200 cubic metres a day lower than previously expected. The Board said that less and slower driving, lower thermostat settings and greater use of car pools, public transport and smaller automobiles would cheaply and quickly eliminate a good deal of the concern over gasoline and heating oil supply.

OIL AND NATURAL GAS

Canada is committed through its membership in the International Energy Agency to holding net oil imports in 1985 to a maximum of 95 000 cubic metres per day. The country adopted a specific target of reducing net oil imports by 16 000 cubic metres per day by the fourth quarter of 1979 - down from 40 000 to 24 000 cubic metres per day.

While there are reasonable prospects of achieving the 1985 targets by taking a new approach to energy policy, the short-term targets are difficult to meet for a number of reasons. Domestic oil production is already pushed nearly to the limit; exports have already been restrained to the point where there is little scope for additional diversions; and domestic demands have continued to grow at an unexpectedly high rate.

Average net imports of oil during the year were 16 000 cubic metres per day and were below the IEA target, and the fourth quarter imports were also below the target.

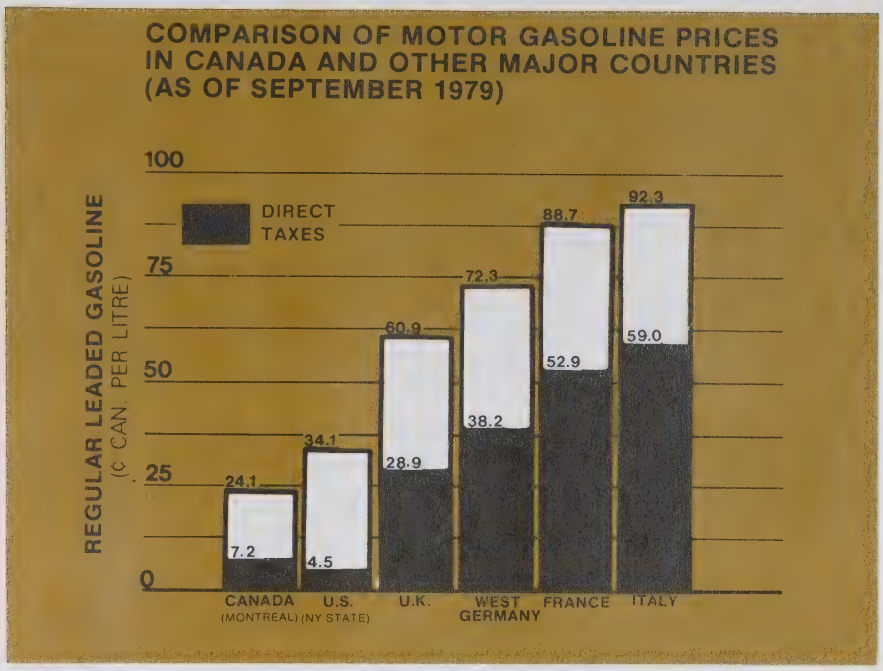
Petroleum product supply at the end of 1979 was up 11.4 per cent over December 1978. This increase occurred, despite a 3.7 per cent growth in demand, because refinery production was up nearly 9 per cent. The increased rates were largely caused by increases in the transportation fuels: aviation turbo fuel up 13.5 per cent, diesel fuel up 12 per cent and motor gasoline, up 3.4 per cent. The other major increase was in petrochemical feedstocks which were up by 23 per cent from 1978. All of the major products, however, had higher closing inventories at the end of 1979 than at the end of 1978.

DOMESTIC PRICES

The average cost of imported oil jumped from $103.83 per cubic metre landed in Montreal in October 1978, to $161.73 and rising at the end of 1979. OPEC announced new increases around the end of the year of about $112 per cubic metre. Domestic prices were $63 per cubic metre less than world prices even before the December increases were announced. The increases were expected to add more than $700 million to Canada's oil bill in 1980.

Since the oil price shocks of 1973, Canada has pursued a policy of gradually raising oil prices towards international levels, with natural gas prices rising so as to maintain their relationship with oil. Natural gas prices are 85 per cent of oil on a heating-value basis. As of the end of 1979, domestic crude oil price increases of $6.30 per cubic metre ($1 per barrel in July 1979) were not sufficient to narrow the gap between the domestic and the international price. The difference is covered by a federal government subsidy on imported oil.

Through restraint of crude oil prices and a relatively light tax burden at the petroleum product level, Canadian energy consumers now pay less than consumers anywhere else in the world. Even if Canada were at international oil-price parity, the cost of motor gasoline, for example, would still be lower than it is in many other countries.



Canada has kept domestic prices below international levels by a combination of measures. Pricing policy in 1979 was governed by understandings reached at the May 1977 meeting of federal and provincial Energy Ministers, which called for four semi-annual price rises, commencing on July 1, 1977.

Because of a short-term surplus of petroleum in world markets during 1978 which restricted the rise in international oil prices, the fourth increase of $6.30 per cubic metre, scheduled for January 1, 1979, was postponed. It was subsequently agreed to effect rises of $6.30 per cubic metre in July 1979, and January 1980.

Measures to help finance the cost of import subsidies include a tax on oil exports equal to the difference between the domestic and the international price ($68.60 per cubic metre at the end of the year). The agreement to hold down oil and natural gas prices, combined with government subsidies have provided benefits of nearly $10 billion a year to consumers - $7 billion for oil consumers and $2.5 billion for gas consumers.

As an incentive to increased domestic production, producers of eligible non-conventional oil from two plants in the Athabasca tar sands have been receiving the equivalent of the international price paid for oil by means of a special levy on all refiners of crude oil in Canada.

PRODUCTION, CONSUMPTION, IMPORTS AND EXPORTS

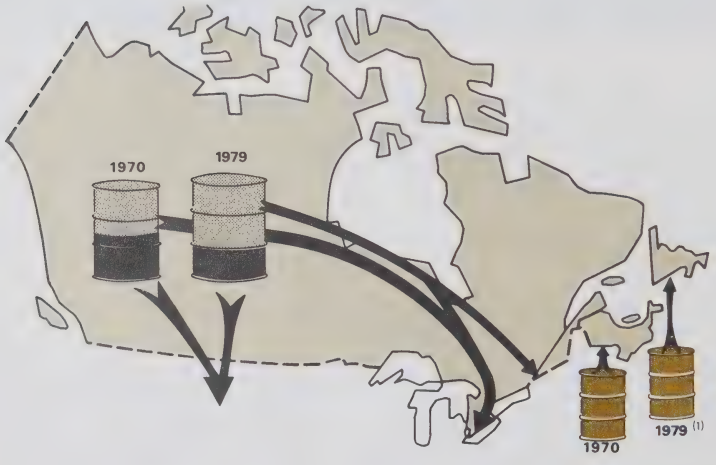
Canadian consumption of crude oil and natural gas liquids in 1979 increased to 302 000 cubic metres from 289 000 cubic metres per day in 1978, an increase of 4.5 per cent. This compares with a growth rate of 4.4 per cent between 1973 and the end of 1977.

As a result of increased western Canadian production following the Iranian crisis, there was a decrease in gross imports, from 106 000 cubic metres per day in 1978 to 100 000 cubic metres per day in 1979.

This reduction can be attributed in part to continued operation of the Sarnia-Montreal pipeline, which operated near capacity delivering western Canadian crude to Montreal area refiners and to "swap" arrangements by which shipments of western Canadian oil to the western United States were offset by diversion of offshore oil from U.S. to eastern Canadian markets.

Exports of all types of oil were increased to 84 000 cubic metres per day in 1979 from 79 000 cubic metres per day in 1978. Crude oil exports increased from 38 300 cubic metres per day in 1978 to 44 000 cubic metres in 1979, but these included the oil swap arrangements.

PETROLEUM IMPORTS AND EXPORTS



1970 (cubic metres per day)		1978 (cubic metres per day)	1979 (1) (cubic metres per day)
235 000	TOTAL CANADIAN PRODUCTION	250 000	281 000
121 000	IMPORTS	106 000	100 000
121 000	EXPORTS	79 000	84 000
234 000	CONSUMPTION	289 000	300 000

Includes refined products and liquefied petroleum gases.
(1) Both imports and exports include about 15 000 cubic metres per day of exchange oil with the U.S.A.

Note: Differences between supply and disposition are due to stock changes, losses and adjustments.

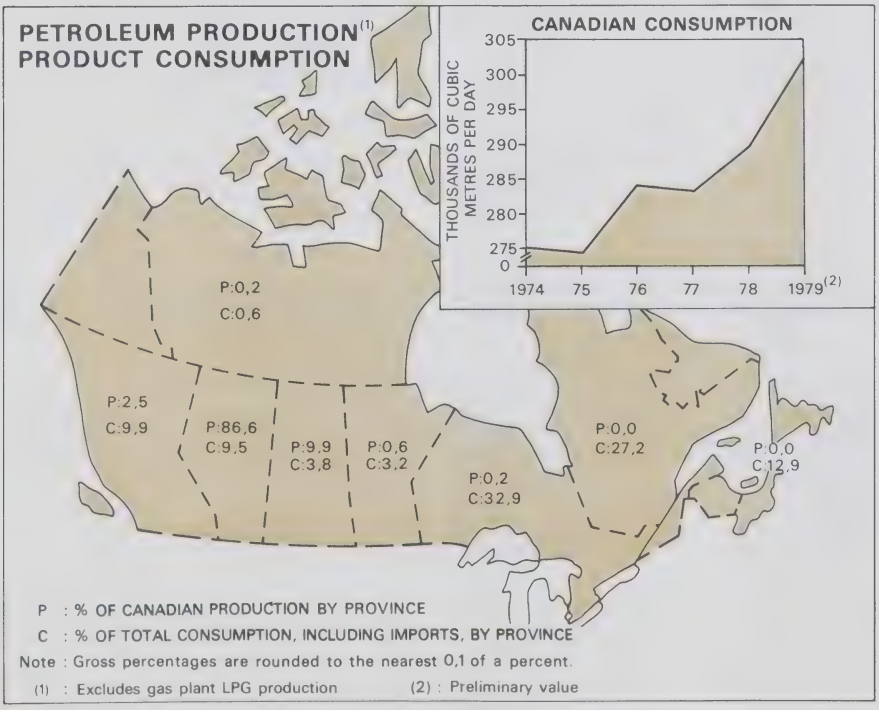
Total Canadian production of petroleum increased in 1979 to an average level of 281 000 cubic metres per day. Conventional crude oil production increased by 23 000 cubic metres per day while synthetic crude oil production increased by 6 000 cubic metres per day. Production of natural gas liquids increased by 9 per cent to 25 000 cubic metres per day.

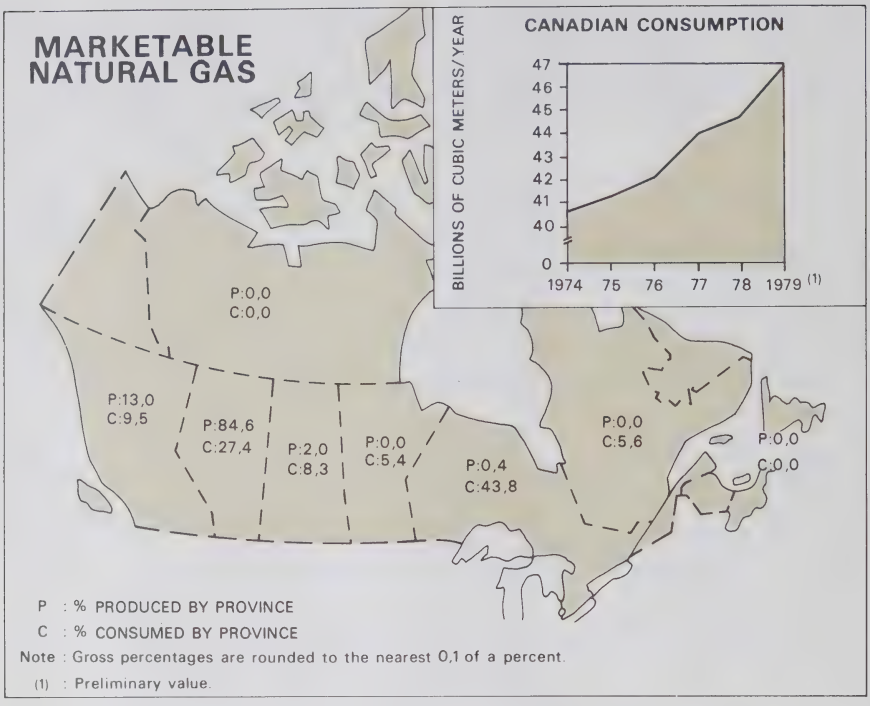
Natural gas sales to Canadian customers increased to an estimated 122.0 million cubic metres per day from 116.5 million cubic metres per day in 1978. Sales to U.S. customers were 28.5 billion cubic metres. Natural gas export revenues increased from $2.2 billion in 1978 to $2.9 billion in 1979, because of higher gas export prices.

On December 6, 1979, the National Energy Board announced that it had recommended new exports up to a total of 106.2 billion cubic metres or 3.75 trillion cubic feet (Tcf). However, the Board recommended that part of the exports be contingent on pre-building of part of the Alaska Highway Gas Pipeline.

The new exports represent an increase of about 40 per cent over the 260 billion cubic metres (9.4 Tcf) remaining under existing export licenses and were the first of any significance endorsed by the Board since 1970. The new gas exports would improve Canada's trade balance by an estimated U.S. $13 billion between 1979 and 1987 at 1979 year-end prices.

At the same time, the NEB said demand for natural gas in Canada would not be as great as earlier anticipated because of higher costs.





EXPLORATION, DISCOVERIES AND RESERVES

In making its announcement, the NEB updated its estimate of natural gas reserves from 1.9 trillion cubic metres to 2 trillion cubic metres. This does not include estimated ultimate gas potential of 1.6 trillion cubic metres in the Mackenzie Delta-Beaufort Sea area, 1.4 trillion cubic metres in the Arctic Islands and 1.1 trillion cubic metres in the East Coast offshore.

Currently, the annual finding rate for gas in western Canada is about 127 million cubic metres - almost twice the 65.4 million cubic metres which was produced for domestic use and export in 1978.

Reserves and finding rates for natural gas are more satisfactory than they are for conventional crude oil in the producing provinces. Established remaining reserves for oil are about 1.1 billion cubic metres. Additions to oil reserves are not keeping pace with yearly production, which was about 87 million cubic metres of conventional and synthetic oil in 1979. The ultimate conventional crude oil potential of western Canada may be about 2.1 billion cubic metres, but much of the remaining potential may be difficult and costly to find and produce.

ESTABLISHED RESERVES – OIL AND NATURAL GAS

(AS OF JAN. 1, 1979)

	INITIAL IN-PLACE	CUMULATIVE PRODUCTION	REMAINING RESERVES
OIL (MILLIONS OF CUBIC METRES)			
LIGHT/MEDIUM CRUDE	1939.4	1187.1	752.3
HEAVY CRUDE	325.6	211.5	114.1
OIL SANDS (ATHABASCA)[1]			
MINEABLE BITUMEN	4830.0	36.0	4794.0
RECOVERABLE SYNTHETIC CRUDE OIL	3620.0	26.0	3594.0
NATURAL GAS (BILLIONS OF CUBIC METRES)			
CONVENTIONAL AREAS	2852.0	946.0	1906.0
FRONTIER AREAS	410.8	–	410.8
TOTAL	3262.8	946.0	2316.8

(1) ESTIMATES OF IN-PLACE DEPOSITS OF BITUMEN RANGE AS HIGH AS 160 BILLION CUBIC METRES; ONLY A FRACTION OF THIS RESOURCE IS RECOVERABLE BY EXISTING TECHNOLOGY.

SOURCE: NATIONAL ENERGY BOARD

SOME MAJOR EVENTS

Possibly important new discoveries were made in several frontier oil and gas regions during 1979. As well, intensive activity in the 58-year-old Norman Wells field raised recoverable reserves there to 40 to 50 million cubic metres, five or six times previous estimates.

-- A potentially important natural gas and condensate discovery was made in the Mobil - Texaco - Petro-Canada well off the eastern tip of Sable Island. The well tested at up to 640 000 cubic metres of gas and 7.5 cubic metres of condensate per day. It was the first potentially commercial discovery of hydrocarbons on the Scotian Shelf after 70 wells and 10 years of almost continuous drilling. Further drilling will be carried out in 1980 to determine whether reserves

are sufficient to warrant the construction of a pipeline to Nova Scotia.

-- As many as eight offshore units were drilling in the fairway stretching from the Grand Banks to Davis Strait during the year. A significant discovery of light gravity oil was made in the Hibernia well 320 kilometres east of St. John's on the northeast tip of the Grand Banks. Three drilling rigs were expected to be active in this area early in 1980. Extensive follow-up drilling will be needed to determine whether the area will yield significant oil production during the 1980s.

-- In the Labrador Shelf area, where four significant wet gas discoveries had already been made, two wells were encouraging. One extended a wet gas discovery of 1973 and the other was a fresh, but relatively small find. No discovery of commercial size has yet been made in this area, given the difficulties of operating in harsh conditions.

-- In Davis Strait, a well off southern Baffin Island produced a significant show of hydrocarbons, enough to warrant further work in 1980.

-- In the inter-Arctic Islands, a well drilled from a reinforced ice platform midway between Melville and Lougheed Islands found a number of gas zones, one of which yielded 230 000 cubic metres per day of gas, with some condensate. This result gives promise of a major new offshore gas discovery that could bring Arctic Islands reserves within range of pipeline threshold volumes. The threshold is 566 billion cubic metres. The new find brings total discoveries to within three-quarters of the amount needed to finance the construction of a pipeline.

-- In the shallow waters of the Beaufort Sea, one oil-and-gas find and one gas discovery were made during the year. The major potential for large oil and gas fields lies in the deeper Beaufort Sea area, where Dome Petroleum has been drilling for four years. The record to date is three discoveries: one oil, one gas and one oil-and-gas well. During 1979, gas was confirmed at a well which was drilled in 1977. Oil flowed at up to 1 100 cubic metres per day from another well on test. It should be noted that no confirmed commercial field has yet been discovered in the Beaufort Sea.

OIL SANDS AND HEAVY OILS

The oil sands and heavy oils of Alberta and Saskatchewan are among the world's largest known deposits of petroleum hydrocarbons. As much as 32 billion cubic metres of oil may ultimately be recoverable from these deposits. However, recovery is technologically complex and very expensive.

The deposits can be divided into three categories: the tar sands of Athabasca, Wabasca and Peace River, which are a mixture of dense bitumen with sand and water; the heavy oils of the Cold Lake, Alberta, region; and the heavy oils of the Lloydminster, Saskatchewan/Alberta, area.

The general characteristic of heavy oil, aside from the high costs of extraction, is that it needs upgrading before it can be readily refined into a variety of petroleum products. Increasing world and domestic prices are making the larger scale production and upgrading of these resources more likely.

The federal and provincial governments have taken a number of steps to promote development of these resources. Favorable tax and royalty regimes have been either proposed or introduced, as already noted.

SOME MAJOR EVENTS

-- The Geological Survey of Canada estimated that there may be 3.2 to 6.4 billion cubic metres of oil in the Alberta portion of the Lloydminster deposits, with as much as 0.8 billion cubic metres recoverable by various techniques. About one and one-half times that amount may be recoverable from the Saskatchewan portion of the deposits. In both cases, however, recovery and upgrading costs will be high.

-- Progress continued on two major projects led by Shell Oil and Esso Resources. Both projects received preliminary approval from regulatory authorities. Alsands consists of a consortium of companies proposing construction of Canada's third oil sands plant, scheduled to begin producing 20 000 cubic metres of oil per day in 1986, from the tar sands. The second plant will recover heavy oil in Cold Lake with expected production of 23 000 cubic metres per day beginning in 1986.

-- Syncrude Canada produced its 800 thousandth cubic metre (5 millionth barrel) of oil.

-- Great Canadian Oil Sands began receiving the international price for oil in return for a commitment to expand production by 2 400 cubic metres per day. GCOS subsequently merged with Sun Oil to become part of a new corporation called Suncor.

TRANSPORTATION

The goal of energy security depends crucially on the ability to move domestic oil and natural gas to those areas which now depend on imported oil. Thus, one of the first responses to the OPEC oil embargo of 1973-74 was to extend an oil pipeline from Sarnia, Ontario, to Montreal. This

pipeline operated near capacity during 1979, delivering western Canadian crude to the Quebec market.

The next logical step is to make maximum use of Canadian natural gas to partially supplant imported oil in eastern Canada. Three proposed systems could contribute to this objective. First, the existing gas transmission system from Alberta to Montreal could be extended to deliver western Canadian natural gas to points east of Montreal. Second, if reserves are sufficient, East Coast offshore gas could be delivered by pipeline to the Maritimes and Quebec. Finally, Arctic gas could be delivered to eastern Canadian markets either by pipeline or by ice-breaking liquefied-natural-gas (LNG) tanker.

In September 1979, the NEB began hearing applications from TransCanada PipeLines Limited (TCPL) and Q & M Pipe Lines Limited on their proposals to expand the natural gas market in eastern Canada. On November 5, 1979, the two companies joined forces to present a joint application, which consists of TCPL's proposal for the Quebec extension and Q & M's proposal for the Maritimes section. The Maritimes section includes a lateral for exports to the U.S. Following this joint submission, the NEB continued its hearings and expected to make a decision by May 1980.

Petro-Canada, Alberta Gas Trunk Line and the Melville Shipping Group have proposed the shipping of more than 7 million cubic metres of liquified natural gas per day from Melville Island in the eastern Arctic to markets on the Canadian or U.S. East Coast, or to Europe. Petro-Canada filed an application for such a project, estimated to cost $1.3 billion ($1979), in January 1979. Hearings by the National Energy Board could commence in mid 1980.

Another proposal for the delivery of Arctic Island gas has been put forward by Polar Gas Limited. In December 1977, Polar Gas filed an application to construct a 42-inch natural gas pipeline designed to bring 38.2 million cubic metres per day of Arctic Islands gas to southern Canadian markets. Polar Gas has now decided that it would be feasible to connect eastern Arctic and Mackenzie Delta gas by a "Y-line" pipeline to Longlac, Ontario, or Winnipeg, at a cost of $9.6 billion ($1979).

In terms of gas expansion in western Canada two proposals, one by Westcoast Transmission Company Limited and the other by British Columbia Hydro have been advanced to build a pipeline to Vancouver Island, the only major western market not served by natural gas.

SOME MAJOR EVENTS

-- Trans Mountain Pipe Line Company Ltd. proposed to build a port at Low Point, Washington, and an oil pipeline from there to Edmonton to carry 80 000 cubic metres per day of Alaskan and foreign crude for delivery through existing systems to the Northern Tier States (which include 12 northern and midwestern states from Washington to Michigan). Trans Mountain applied to the NEB in April to construct the Canadian section of this line.

-- Foothills Oil Pipe Lines Limited announced on August 10 that, instead of its port-pipeline system, it would seek to build an overland pipeline from Alaska to Edmonton to deliver 80 000 cubic metres per day of Alaskan crude to the Northern Tier.

-- In September, the Canadian government informed Washington that it preferred the Foothills overland route. Foothills then withdrew from the NEB hearings on October 15 and the NEB continued to review Trans Mountain's application. At year's end, the U.S. President was to select a west-to-east oil delivery system for expedited federal regulatory approval.

-- Foothills Pipe Lines Limited filed an application in June to build the Dempster Highway Gas Pipeline which would link Mackenzie Delta gas with the Alaska Highway pipeline near Whitehorse. This line would be designed to carry 33 million cubic metres per day of natural gas.

-- Foothills, jointly owned by Westcoast Transmission and Alberta Gas Trunk Line Company Limited, announced that the start-up of the Alaska Highway Gas Pipeline would be delayed until November 1984. This large-diameter natural gas pipeline would carry up to 67 million cubic metres per day of Alaska gas to U.S. markets. Cost of the pipeline is estimated at $6 billion for the Canadian portion and $9 billion for the U.S. portion (as-spent dollars). The NEB completed three of the four phases of its hearings on financing and other matters related to the Alaska Highway Gas Pipeline.

-- Imperial Oil Limited announced plans to develop its oil reserves at Norman Wells. Interprovincial Pipe Line Company would build a small diameter pipeline from Norman Wells to connect with the existing oil pipeline system in northern Alberta. The pipeline would carry 4 000 cubic metres per day.

REPLACING OIL

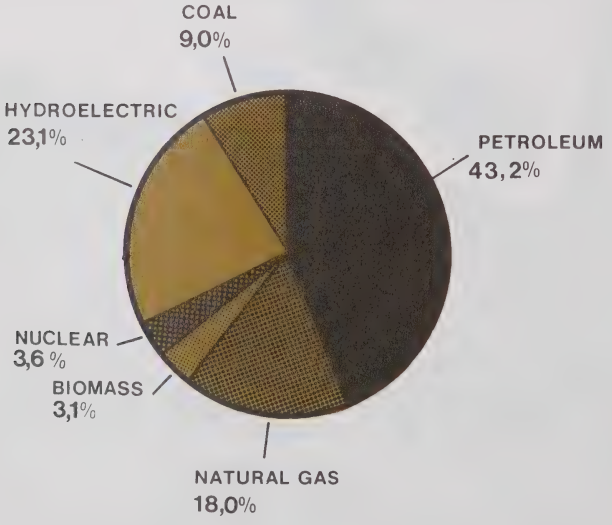
Canada's total consumption of energy excluding biomass in 1979 is estimated to have been about 9 414 petajoules of primary energy. This is the equivalent of about 240 million cubic metres of oil for the entire country, or 10 000 litres per capita.

Climate, long transportation hauls and a high standard of living have made Canada one of the biggest users of energy per capita in the world. Only Luxembourg, with a small population and much heavy industry, uses more energy per capita than Canada does.

Of total energy consumed in Canada, including biomass, 43 per cent is accounted for by oil; 23 per cent by hydro electricity; 18 per cent by natural gas; 9 per cent by coal; 4 per cent by nuclear generation and 3 per cent by biomass. Our energy needs cost the economy $22 billion in 1979, or about 10 per cent of Gross National Product.

Our production of all forms of energy in 1979 was about 10 400 petajoules, 6 per cent greater than demand. However, this small surplus conceals a wide variety of surpluses and deficits in individual fuels. Even when considering a single fuel, there are wide differences in production and consumption patterns across the country.

SOURCES OF PRIMARY ENERGY



In general, western Canada is a net exporter of energy, especially oil, natural gas and coal, while eastern Canada, including Manitoba, is a net importer. There are exceptions in certain forms of energy. Hydro-electric generation, for instance, is abundant in Newfoundland, Quebec, Manitoba and British Columbia. British Columbia is a producer of both oil and natural gas but is a net importer of oil.

About 34 per cent of the total oil consumed in Canada is used for road transportation according to statistics compiled for 1978. The next largest consumers are the industrial sector, including non-energy products (23 per cent) and residential and farm (15 per cent). As for natural gas, the industrial sector is the largest end user at 46 per cent, followed by residential and farm (24 per cent) and government and commercial (20 per cent).

According to a recent forecast by the Department of Energy, Mines and Resources, total primary energy demand in Canada is expected to grow at about 2.2 per cent per year to the year 2000. This compares with an average rate of 5.3 per cent per year prior to 1973 and 3.0 per cent between 1973 and 1979. This estimate is based on the assumption that international oil prices will increase from present levels at 2 per cent per year and that Canadian prices will move to parity with international prices by 1986.

Projections indicate that Canadians could be consuming the energy equivalent of 12 660 litres per capita by the year 2000, an increase of 24 per cent from current levels. However, total real expenditures on energy are expected to increase by 139 per cent between now and 2000, from 10 to 10.6 per cent of Gross National Product.

Among energy sources, nuclear power is projected to increase its share of total consumption most rapidly, from 3.5 per cent in 1979 to 9.1 per cent in 2000. Meanwhile, the relative shares contributed by oil and gas are expected to fall from 67.0 per cent of the total in 1978 to 47.4 per cent in 2000.

Even though the relative share of oil will fall sharply, from a 43 per cent share now to about 30 per cent in 20 years, Canadians will still be consuming about 33 000 cubic metres per day more in 2000 than they are today. This is the equivalent of the production from one and two-thirds Syncrude-scale oilsands plants.

These statistics contain the crux of Canada's energy dilemma. The National Energy Board projects that the production of petroleum products in Canada will fall to 212 000 cubic metres per day in 1990, while demand will rise to 339 000 cubic metres per day leaving a net deficit of 127 000 cubic metres per day to be filled by imported oil.

The substitution of more abundant fuels for scarcer ones, particularly substitution away from oil consumption, is thus a matter of primary concern in the development of national energy policies. Indeed, Canada is committed through its membership in the International Energy Agency, to promote subsitution wherever feasible.

The scope for substitution and the best commodity to substitute for oil varies from region to region. Conversion to hydro-electric generation is possible in some areas. The use of coal, or a mixture of coal and oil in place of oil-fired generating stations is possible in the Atlantic region and elsewhere. There are possibilities of conversion to fuel from biomass in several provinces. But perhaps the best opportunity for Canada to substitute away from oil is through expanded use of natural gas.

Development of natural gas as a substitute for oil depends on many factors, including production capacity, consumption patterns and relative price versus oil. In the Atlantic region, where there is a strong dependence on imported oil, it is especially true that natural gas must be priced low enough to allow it to compete with oil, therefore making it reasonable for consumers to convert.

If the market for natural gas were expanded into Quebec and the Maritimes, demand might rise from 44 billion cubic metres in 1978 to at least 70.5 billion cubic metres in 1990. At the same time, production is projected to increase from 70.2 billion cubic metres to at least 80.1 billion cubic metres in 1990.

Balancing the benefits of additional gas sales in new domestic markets are the potential revenues foregone on exports. Canadian gas exports to the United States are priced in relation to the average cost of crude oil imported into Canada. At the end of 1979, the export price was $3.77 per gigajoule at the border, compared to a Toronto city gate price of gas for domestic consumers of $2.00 per gigajoule.

If gas is made available in new domestic market areas, and it is priced so as to reflect its relative abundance compared to oil, a substantial substitution of gas for oil is possible. In other markets where the real costs of delivering gas may be less competitive, it may be more attractive to encourage substitution towards other sources such as coal or renewables.

During 1979, the National Energy Board began hearings into expansion of natural gas to Quebec and the Maritimes. Depending on the NEB decision, a pipeline could be extended to Trois-Rivieres by November 1980, and to Quebec City by November 1981. Further extension of the pipeline in the Eastern Townships, Lac St-Jean and the Maritimes area could be undertaken from 1982 to 1984. About 3 billion cubic metres of natural gas per year could be flowing to these regions in 1985 and over 6 billion cubic metres per year by 1990. These amounts would displace 8 000 cubic metres per day of oil in 1985 and 16 000 cubic metres per day in 1990. At today's prices, this could mean a saving to Canada of $1 billion a year in 1990.

CONSERVATION

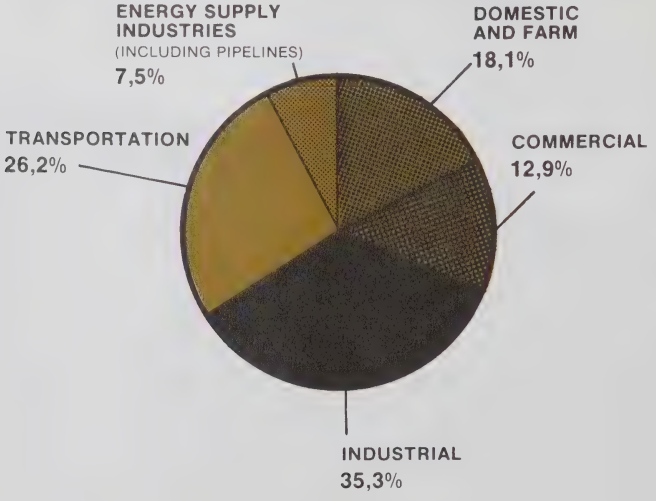
The federal government is committed to a strong national effort in energy conservation. Major energy-saving opportunities have been identified in the main end-use sectors: the industrial, transportation, residential, commercial and public sectors.

To help realize these opportunities, a federal conservation program has been developed. It includes insulation grants; the development of new building codes; energy audits for commercial and industrial establishments; voluntary conservation targets for industry; information programs in all sectors; fuel-economy standards for passenger cars; research, development and demonstration programs; energy labelling of consumer products; and a conservation program covering energy use by federal departments and agencies.

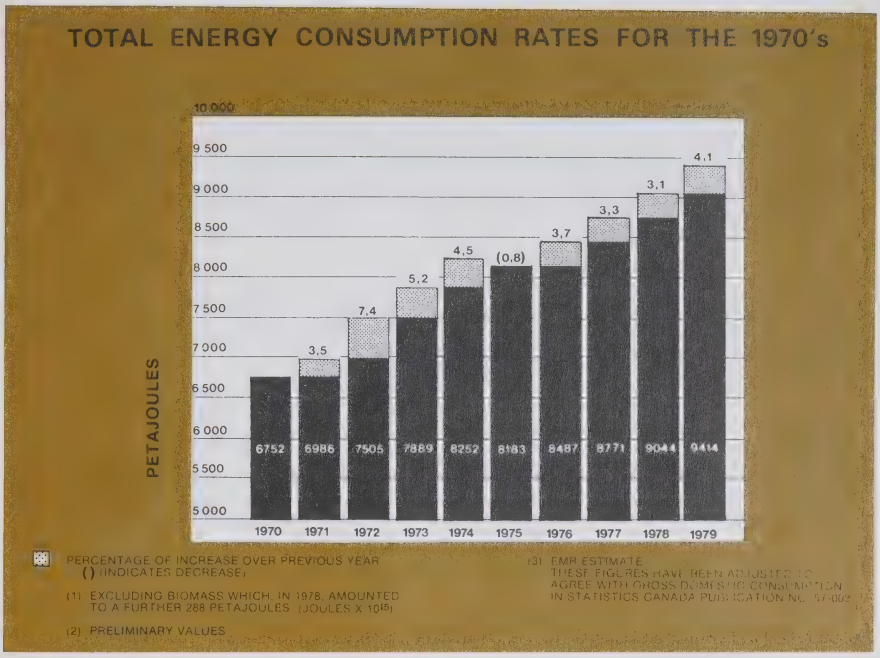
However, the development of appropriate energy prices, which discourages energy waste and at the same time encourages increased development of energy supplies, is central to the conservation effort.

Total federal expenditures on energy conservation programs were more than $82 million in fiscal year 1978-79. In addition, provincial governments spent an estimated $13.5 million during the year.

CONSUMPTION OF SECONDARY ENERGY



In the public sector, the federal government reduced its overall energy consumption by 11.3 per cent during the fiscal year 1978-79, through the "Save 10" program. The objective is to reduce the total energy consumption of the federal government by 10 per cent from the 1975-76 level and to hold that level for 10 years; this target has been achieved, but the activity will require significant continuing effort if the success is to be maintained.



In the industrial sector, 14 energy conservation task forces have been created to emphasize voluntary participation by broad industrial sectors. The initial goal was to cut energy per unit of industrial output by 12 per cent during the 1972-80 period. This has been achieved and task forces are now setting goals for the 1980-85 period.

During the year, the Energy Bus Program, which provides on-site computerized energy audits to industry, business and public institutions, was expanded from Prince Edward Island and Nova Scotia to include all provinces, except Manitoba, under federal-provincial agreements. As a result of the energy bus audits, an average energy saving of over 15 per cent is identified in each plant visited. The audits are not meant to be comprehensive, and a more detailed plant analysis by plant engineers or consultants would identify further cost savings. A set of 11 reference manuals was developed to complement this program.

To accelerate the rate at which firms undertake research and development in energy conservation, the government has established the Industrial Energy Research and Development Program, which can provide up to 50 per cent of the cost of approved research and development projects. Other financial support programs include an Energy-from-the-Forest (ENFOR) research and development program to develop the conversion of biomass to fuel; federal-provincial cost-sharing for the demonstration of state-of-the-art technologies in conservation and renewable energy; and a Forest Industry Renewable Energy Program (FIRE) which provides investment

grants (up to 20 per cent) to encourage forest industries to make greater use of forest biomass.

In the area of taxation, the federal sales tax has been removed from a list of equipment and devices designed to conserve energy or develop renewable forms of energy. Accelerated capital cost allowances are permitted on equipment which uses municipal, industrial or wood waste to produce heat or generate electricity. At the same time, a special excise tax has been placed on automotive air conditioners and on cars weighing more than 2 007 kilograms.

In spite of efforts to encourage greater public transit use, the majority of Canadians continue to travel to work by auto, and the average occupancy rate remains at 1.4 persons per car. Demonstration vanpools, promoting the use of vans by commuters who are not well served by public transit, began operation in the fall of 1979.

The Ener$ave program, providing computerized energy consumption analysis to households was made available throughout the country during 1979.

A federal-provincial program to demonstrate new conservation and renewable energy technologies began during the year with federal funding of $113 million over five years. Provinces will also provide funds for the projects. The budget for fiscal year 1979-80 is $5.5 million.

The agreements provide for the joint review of plans and budgets, and selection of projects. The provinces, however, will be responsible for managing the projects.

An example is a major solar energy demonstration project in British Columbia, involving the construction of up to 100 solar domestic hot water installations. This project, funded under the Canada-British Columbia agreement will cost more than $300 000, with the federal and provincial governments contributing $100 000 each.

Information on approved projects is available to the public on the Canadian Energy Projects automated data base, which was launched during the year. The data base includes project names, location and contact person, management and funding information, present status, references to any project publications, classification references, key words and a description of the salient features of the project.

The Department of Energy, Mines and Resources also provides funds for a number of special projects, including a waste-burning plant in Charlottetown, Prince Edward Island, and a program to conserve energy at the St. Lawrence Cement plant in Mississauga, Ontario.

The cost of the St. Lawrence Cement plant project is estimated at $21 million, with about $2 million provided by EMR. The three-phase program includes the production of electricity from waste heat; the use of solid fuels, such as coke and coal, as a substitute for oil; and the use of slag from steel plants as a constituent in cement. This program, which began in the latter part of 1978, was well under way during 1979.

SOME MAJOR EVENTS

-- October was designated as the First International Energy Conservation Month (IECM) by the International Energy Agency. IECM activities in Canada focused on the long-term benefits of conservation and the development of international cooperation. Participants included citizens' groups, members of the business community and individual Canadians. Canada's major contribution was an industrial energy conservation conference in Toronto, which provided an opportunity for government and industry to exchange views on energy conservation opportunities.

-- The Canadian Home Insulation Program (CHIP) was expanded during the year to include all homes built prior to 1961, providing up to $350 for the cost of insulation materials and up to two-thirds of the cost of labor, to a total of $500. This promoted a substantial increase in applications for CHIP grants.

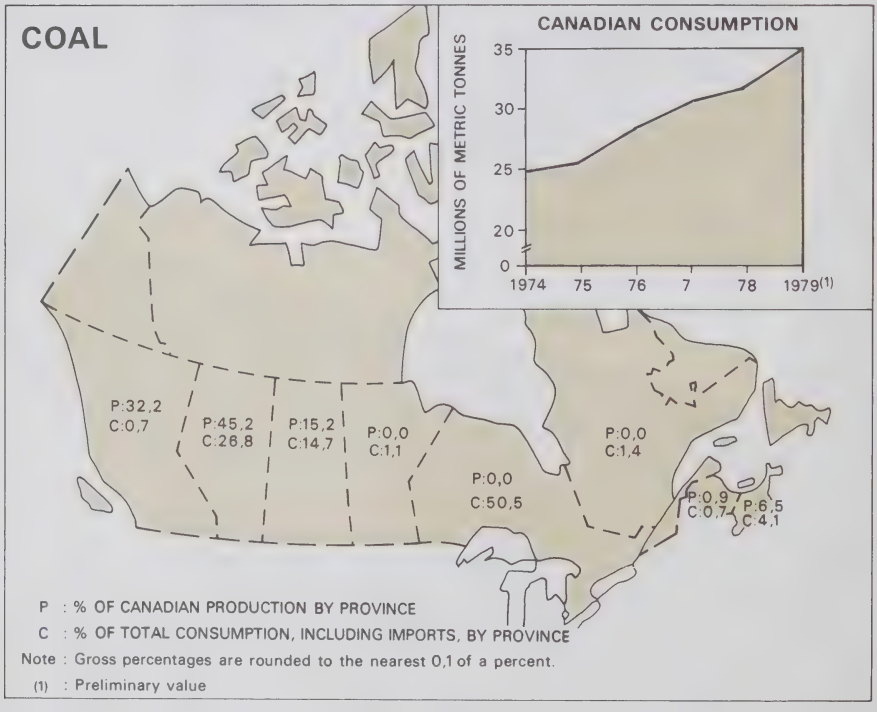
-- Approximately $4.8 million was expended in fiscal year 1978-79 on energy conservation education and information programs directed at all energy use sectors. More than 6 million requests for free energy conservation booklets had been filled by the end of 1979.

COAL

Coal continued to attract renewed interest as an energy source in Canada as production of this fossil fuel, virtually forgotten when gas and oil reserves seemed limitless in the 1950s, was stepped up to meet growing demands.

During 1979 Canada continued to look for ways to substitute Canadian coal for oil and gas to reduce our dependence on expensive and often unreliable offshore energy sources.

Expansion and development of new thermal generating stations will increase the contribution of coal and research is probing into new ways to use this resource in other important applications. Increased coal consumption in the 1980s may result from conversion of oil-fired electrical generating systems to coal or coal-and-oil mix.



About 72 per cent - or 25 million tonnes - of all the coal consumed in Canada during 1979 was used to produce electricity. As more new stations are built in the west and as coal is substituted for oil, particularly to convert generating plants in Nova Scotia and New Brunswick, this percentage will increase.

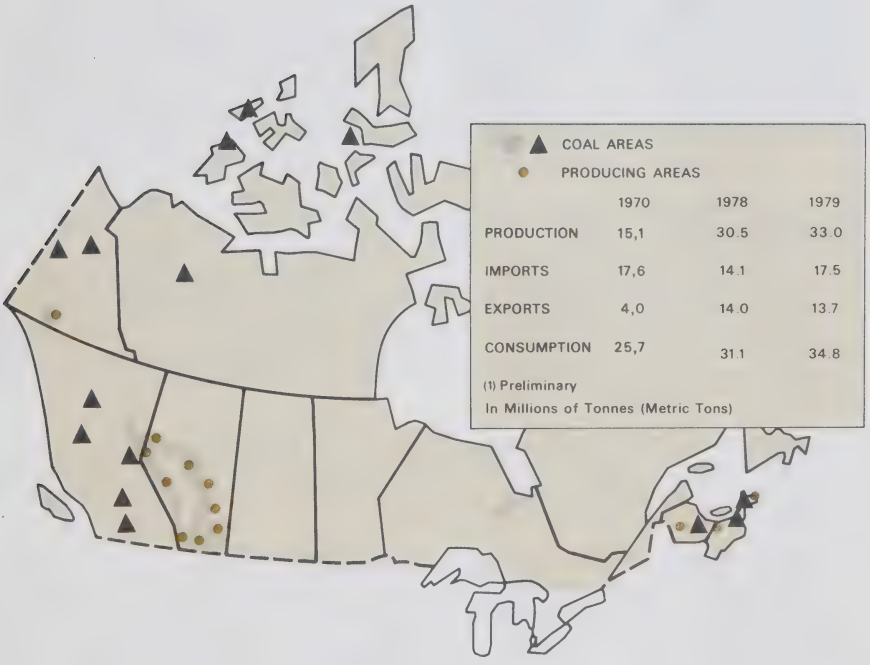
Development of fluidized-bed combustion plants with clean-burning, environmentally acceptable systems is an important step toward greater use of coal. The fluidized-bed system prevents the sulphur from entering the atmosphere, thereby making it environmentally more acceptable. It

also has the advantage of a lower capital investment requirement than other systems. Fluidized-bed combustion is currently being demonstrated in the Atlantic provinces.

Coal can be converted into synthetic gas and liquid fuels. It can supply the thermal requirements of the tar sands and heavy oil plants, thus increasing the oil yield from these sources. The direct hydrogenation of coal can produce a range of synthetic petroleum products such as fuel oils, transportation fuels and chemical feedstocks, but this like other options, requires large capital investments.

Coal gasification technology to produce a substitute for natural gas is also available but large discoveries of natural gas in the past few years have made this process economically unattractive at present.

COAL IMPORTS AND EXPORTS



	1970	1978	1979
PRODUCTION	15,1	30.5	33.0
IMPORTS	17,6	14.1	17.5
EXPORTS	4,0	14.0	13.7
CONSUMPTION	25,7	31.1	34.8

(1) Preliminary
In Millions of Tonnes (Metric Tons)

PRODUCTION AND RESERVES

Production of coal from Canada's 50 producing mines reached 33 million tonnes in 1979, an increase of 2.5 million tonnes from the previous year

and 23 million tonnes more than total production just a decade ago. The 1979 production was valued at $836 million compared to the 1978 production value of $776 million.

Alberta continued to be Canada's leading coal-producing province during the year with total output of 14.9 million tonnes - up some 11 per cent from the previous year's levels. British Columbia production increased from 9.1 million tonnes in 1978 to 10.6 million tonnes in 1979. New Brunswick and Saskatchewan production remained almost the same and Nova Scotia reported a 0.5 million tonnes decline in production.

Canadian exports amounted to 13.7 million tonnes as offshore markets continued to gain momentum. Most of this exported coal was used in steel-making. Imports also increased, exceeding 17.5 million tonnes in 1979. The proximity of U.S. coal fields to coal markets in Ontario has traditionally left Canada in a coal trade deficit position. However, Ontario Hydro's recent commitment to use western Canadian coal will help reverse this trend.

In December 1979, the latest assessment of coal resources and reserves published by the department estimated measured resources of immediate interest at 16.8 billion tonnes of bituminous coal, 30 billion tonnes of subbituminous coal and 3.6 billion tonnes of lignite coal. Mineable reserves were put at 7.3 billion tonnes of subbituminous, 5.6 billion tonnes of bituminous and at least 3.2 billion tonnes of lignitic coal.

SOME MAJOR EVENTS

-- The Korea Electric Company signed agreements with three southern British Columbia companies for 3.5 million tonnes of thermal coal to be shipped over a five-year period. Suppliers will be Crows Nest Resources, Kaiser Resources Ltd. and Fording Coal Limited. Crows Nest Resources will open a new mine at Line Creek to meet its contract commitments.

-- Canada moved closer to expanding its West Coast ports to facilitate coal export shipments. Government and private officials continued to evaluate the need for new terminal capacity in the early 1980s at both Vancouver and Prince Rupert.

-- Major interprovincial thermal coal movements between western Canada and Ontario began during 1979. More than 2.2 million tonnes of bituminous coal were shipped from mines in British Columbia and Alberta to Ontario Hydro's Nanticoke thermal generating station on Lake Erie. By the mid-1980s approximately 4 million tonnes of western Canadian coal may be moving through a 3 500-kilometre rail, coal-terminal, lake-freighter system.

-- Alberta will soon be Canada's leading thermal coal consuming province as 2 250 megawatts of new coal-fired generating capacity is either under construction or approved. Two 375-megawatt units will be added to existing thermal stations in 1981. And two new 750-megawatt stations are scheduled to come on stream in Alberta in the mid-1980s.

-- New Brunswick added 200 megawatts of thermal generating capacity during 1979 when the new coal-and-oil, Dalhousie II station was commissioned with oil in November. Commissioning with coal will occur early in 1980. Nearly 300 000 tonnes of coal will be required annually to fire this station. Most of this requirement will come from a new mine near Salmon River.

-- The first of two new 150-megawatt coal-fired thermal generating units came on stream at Lingan on Cape Breton Island during the year. The second unit is now scheduled to become operational in 1980.

-- Work was nearing completion during the year on the first 300-megawatt unit of the new Poplar River power station and related strip-mine development in southern Saskatchewan. Late in the year, the provincial government announced that it would proceed with a second 300-megawatt unit that should be in operation by 1982.

-- Canada joined the 30-country Coal Industry Advisory Board of the International Energy Agency. The objective of this board is to increase the substitution of coal for other energy forms.

-- The Ontario government announced plans to spend up to $6 million to study the possibility of recovering coal from deposits in the James Bay area. Use of this coal is seen as a long-range program that would require gasification. The studies are going to be carried out over a period of up to five years.

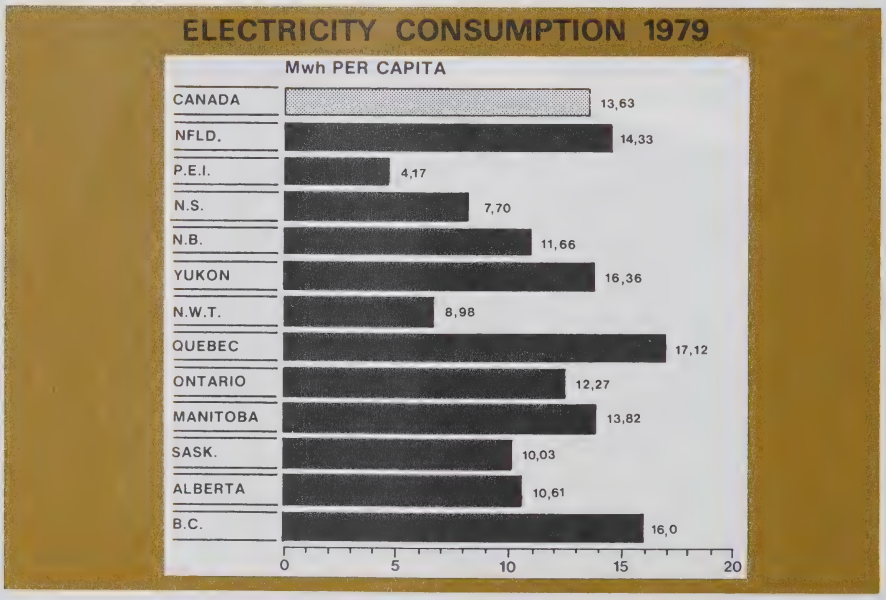
ELECTRICITY

Electricity is one of the key elements in Canada's energy future. Forecasts indicate that it will play an increasingly important role between now and the year 2000. The report: "Canadian Electricity Supply in a Period of Uncertainty", prepared by EMR in 1979, predicts that electricity will contribute 47.5 per cent of Canada's energy requirement within 20 years. Currently electricity is providing 37 per cent of the total energy demand.

Canada increased electricity generating capacity in 1979, particularly in Quebec, Alberta, Ontario and the Maritimes. Water power, the only significant renewable source of electrical production, generated almost 70 per cent of our total electrical energy during the year. This equalled nearly one-quarter of Canada's total primary energy needs. Coal and uranium accounted for the balance of electricity production, supplemented by small amounts of oil and gas.

For the past five years the government has encouraged the reinforcement of regional interconnections for the transmission of electricity by offering loans to provide 50 per cent of the costs of approved projects. Applications for this assistance have come mostly from the Maritime provinces, but Manitoba has now been provided with loans of over $100 million for the second stage of the Nelson River transmission system between northern Manitoba and the Winnipeg area.

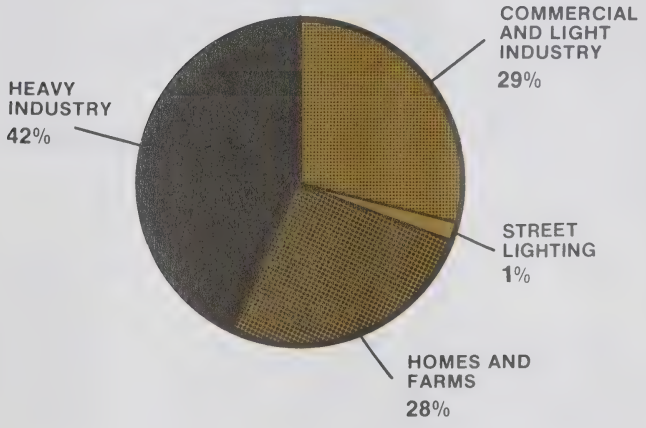
Canada's net export of electricity increased in 1979 by more than 48 per cent, thus increasing export revenues from electricity to $729 million in 1979 from $479 million in 1978.



During 1979 Canada and the U.S. released a study of electricity exchanges. The study concluded that significant opportunities existed for increased international exchanges in all border regions, and that these exchanges could reduce oil consumption and increase the reliability of electricity supply.

While identifying obstacles to the development of exchanges, the report recommended increased communications and liaison among regulatory agencies, action on export pricing to achieve the maximum benefits from the exchanges and development of public information programs to explain the benefits exchanges provide.

CANADIAN CONSUMERS OF ELECTRICITY



PRODUCTION

Canadian electrical generating capacity increased by 3 406 megawatts to 77 974 megawatts in 1979. More than one-third of this 4.6 per cent capacity increase became available when the James Bay, Quebec, hydro project started four units in October 1979. This major project alone increased capacity by 1 332 megawatts. Long Spruce, Manitoba, capacity was increased 392 megawatts; Peace Canyon, British Columbia, 350 megawatts; and Mactaquac, New Brunswick, 220 megawatts.

Smaller installed capacity increases were realized at Dalhousie, New Brunswick; Clover Bar and Medicine Hat, Alberta; Holyrood, Newfoundland; Keogh, British Columbia; Lingan, Nova Scotia; Jenpeg, Manitoba; and Iles-de-la-Madeleine, Quebec.

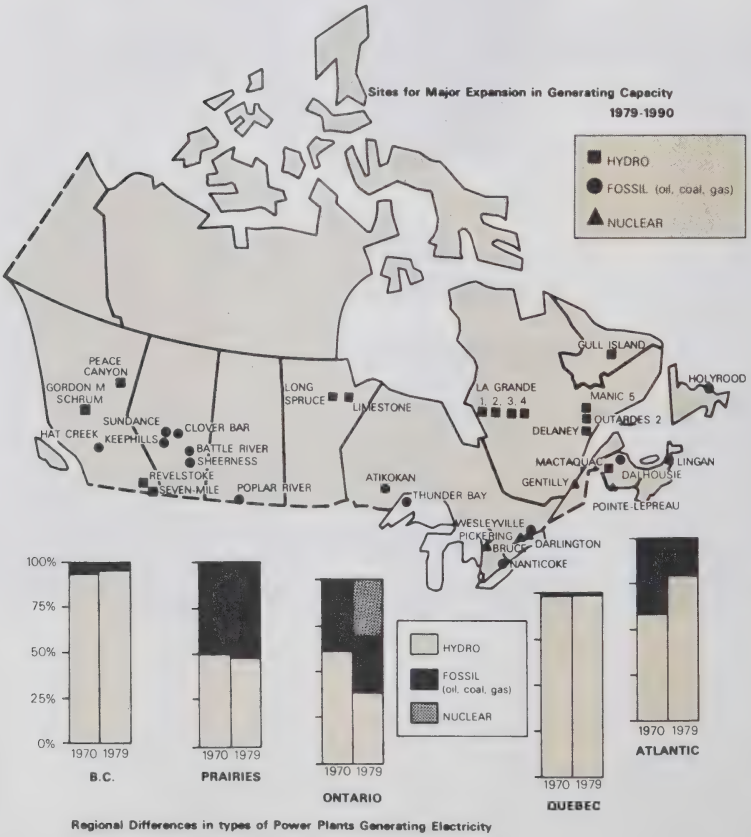
SOURCES

The nuclear energy role expanded during 1979 as uranium generated 9.4 per cent of Canada's electrical production compared to 8.8 per cent in 1978. In Ontario nuclear generating stations now provide 28.5 per cent of the province's electricity supply.

The amount of electrical power generated by fossil fuels remained almost constant.

British Columbia, Manitoba and Quebec relied almost entirely on hydro generation (see illustration) during the year while Alberta and Saskatchewan depended largely on coal. Alberta will soon become Canada's leading thermal coal consuming province as 2 450 megawatts of new coal-fired capacity is approved or under construction. Ontario and the Atlantic region also use hydro as their prime sources, although nuclear power continued to increase its contribution in Ontario and oil continued to play a prominent role in the eastern provinces.

ELECTRICITY IN CANADA 1979-1990



Regional Differences in types of Power Plants Generating Electricity

SOME MAJOR EVENTS

-- Four units, each with a capacity of 333 megawatts, were activated at LG-2 site, James Bay, Quebec, in the fall. The LG-2 project, to be completed by 1982, will eventually have 16 units and total output capacity of 5 328 megawatts.

-- Feasibility studies by the joint federal-provincial Lower Churchill Development Corporation were nearing completion by the year end. It is expected that the Corporation will present recommendations to shareholders by May 1980. Under study are two sites for hydro-electric development, downstream from Churchill Falls, one at Gull Island (1 800 megawatts) and the other at Muskrat Falls (600 megawatts).

-- Encouraging test results from exploratory drilling near Meager Creek, British Columbia, indicated significant geothermal potential which could lead to Canada's first geothermal power generating plant. Geothermal power uses steam trapped beneath the earth's surface to drive electrical generators.

-- The Saskatchewan government approved building a second coal-fired plant at Poplar River, although the International Joint Commission has not delivered its final report on the effects on water quality. The need for additional power stems from industrial expansion, development of new potash mines, increased energy requirements for farming and growth of resource projects. The 300-megawatt Poplar River unit 1 is scheduled to produce power for the Saskatchewan grid by May 1980, and Poplar River 2, a $170 million, 300-megawatt unit, is slated for start-up early in 1982. The controversy surrounding Poplar River developments is the result of Montana residents' contention that the plant will result in soil and air pollution in that state.

-- In the budget speech of May 1979, the Manitoba government froze power rates for a five-year period for all Manitoba electrical consumers other than bulk purchasers and those on other separate contracts. This was made possible mainly by the province relieving Manitoba Hydro of costs associated with its foreign debt by replacing it with the cost of equivalent Canadian debt.

-- Ontario Hydro announced that it was re-examining its construction plans as a result of a new forecast indicating that load growth would be lower than previously expected by the year 2000. In matching the expansion program to the forecast, Ontario Hydro cautioned that it would have to consider other factors, such as economics of production, the cost penalties of changing construction schedules, security of supply, and effects on employment. Ontario Hydro said that the main reasons for the lower estimates are customers' response to conservation, higher rates, and general economic assumptions that include lower projections for population growth, employment and productivity.

URANIUM AND NUCLEAR ENERGY

Almost 20 years have gone by since Canada began using nuclear energy to produce electricity. Its growing importance is evident from its impact on overall electrical production. The 10 CANDU natural uranium reactors operational in Ontario during 1979 produced 30.5 per cent of the province's total power generation. Currently, 12 more plants are under construction in Ontario, one in Quebec and one in New Brunswick.

Canada has an existing installed capacity of 5 500 megawatts and domestic consumption of uranium in 1979 was 980 tonnes. When the plants under construction are completed the annual requirement to fuel all of the nuclear facilities will be approximately 2 500 tonnes of uranium. Domestic utilities are expected, under federal guidelines, to contract for supplies 15 years into the future.

Much attention was on nuclear plant and uranium safety during 1979. A number of studies and inquiries into the industry were commissioned during the year, and the Ontario Select Committee on Ontario Hydro Affairs issued its report on the Safety of Ontario's Nuclear Reactors. This report expressed satisfaction with the level of safety being applied at operating plants, but did make 20 recommendations. Among them, it suggested:

-- a council with representatives from outside the nuclear establishment be formed to bring public participation into reviews of problems associated with operating or planned reactors;

-- the Atomic Energy Control Board (AECB) report to a minister other than the Minister of Energy, Mines and Resources;

-- a study should be commissioned by July 1, 1980, to analyze the possibility and consequence of a catastrophic accident in a CANDU reactor;

-- AECB membership should be broadened to include public representation;

-- AECB proceedings and meetings should, by and large, be open to the public.

Some dissenting opinions and further concerns will be dealt with when the committee reconvenes in 1980. Conclusions expressed in the interim report could change following further investigation and completion of the final report.

The British Columbia Government established the Bates Enquiry during 1979, asking it to examine the regulatory aspects of uranium mining.

Following the Three Mile Island nuclear power plant accident in the United States, an examining commission made a series of recommendations to improve the level of safety. Most of the recommendations the U.S. Commission made either did not apply to the Canadian situation or were already standard practice in Canadian operations. Nevertheless, the findings of the Ontario Select Committee focused on the vital need to maintain strict safety measures in the Canadian operations.

PRODUCTION

Uranium production in 1979 was an estimated 6 811 tonnes, compared to 6 803 tonnes of uranium in 1978. Ontario mines produced about two-thirds and Saskatchewan mines one-third of Canadian production.

Shipments of uranium from production and inventory reached 6 956 tonnes of uranium valued at $664 million in 1979. In 1978 Canada shipped 8 211 tonnes valued at $618 million. Ontario shipments accounted for 4 419 tonnes of uranium, while Saskatchewan producers shipped 2 537 tonnes in the latest year.

URANIUM PRODUCTION,1979

EXPORTS

While uranium and nuclear technologies represent important exports for Canada, these are made under Canadian policies directed at ensuring application to peaceful purposes. Exports to non-nuclear weapon states are restricted to countries that either ratify the Non-Proliferation Treaty or otherwise respect international safeguards on their entire nuclear programs. Canada maintained its position as the second major supplier in the world after the U.S. Of the 6 956 tonnes of uranium shipped by Canadian producers in 1979, some 86 per cent was destined for export markets, primarily in Japan, western Europe and the United States.

At the end of 1979, total forward export commitments of all Canadian producers were 52 400 tonnes uranium. Canadian export policy protects future uranium requirements for domestic nuclear energy programs.

URANIUM RESOURCES

The Uranium Resource Appraisal Group (URAG) of EMR completed its fifth annual (1978) assessment in early 1979. The results of URAG's 1978 uranium resource assessment were published in June 1979.

Comparison of the 1978 estimates with those published a year earlier, indicates only a slight decrease in the measured category, despite production of 6 803 tonnes of uranium, a 44.9 per cent increase in the indicated and a 5.0 per cent decrease in the inferred category. Overall, allowing for 1978 production and taking into account processing recoveries (93.2 per cent for existing conventional deposits), resources in these three categories combined[1] increased by some 7.4 per cent over those quantities reported in 1978. While the increase in the indicated category was largely a result of continued evaluation of Saskatchewan's Key Lake and Collins Bay "A" deposits, the major contributors to the overall increase in the three resource categories were discoveries in the Rabbit Lake area (Midwest Lake and Collins Bay "B" deposits) of northern Saskatchewan and in the Schultz Lake area, west-northwest of Baker Lake, Northwest Territories.

EXPLORATION

There was activity throughout Canada as exploration expenditures were expected to reach at least $90 million, the level that had been reported for 1978.

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(1) Only resources in the measured, indicated and inferred categories are considered for domestic allocation purposes.

The most promising recent find at Midwest Lake in Saskatchewan was announced early in 1978. Esso Minerals of Canada, operators and major owners of the site, reported that based on 279 drill holes the deposit contains 2 million tonnes of ore with an average grade of 1.06 per cent uranium.

In May 1979 Canadian Occidental Petroleum Ltd announced the discovery of the McLean Lake deposit, about 11 kilometres northwest of Rabbit Lake, Saskatchewan. The deposit is being evaluated jointly by Canadian Occidental and Inco Metals Company.

INVESTMENT

Amok Ltd. is investing some $165 million to develop its Cluff Lake, Saskatchewan, project, the first phase of which will commence production by late 1980 or early 1981 at a rate of 1 500 tonnes of uranium per year.

NUCLEAR WASTES

The safe disposal of nuclear fuel and other radioactive wastes continued to be a priority of government and industry in 1979.

The two major considerations are disposal of nuclear fuel waste and the effects of exposure to the tailings left as waste after removal of uranium at the mines.

A group of scientists studied Canada's management of nuclear wastes in 1977 for Energy, Mines and Resources and found that the present methods of storage are acceptable, but long-term disposal required much more research.

Fuel wastes are now stored in supervised pools at each plant site. Researchers in both Canada and the United States are studying means of safe, long-term, unsupervised disposal. Deep burial in the rock of the Canadian Shield is being examined by Atomic Energy of Canada Limited both in field operations and laboratories, with a view to establishing a system by the year 2000.

Research is also being carried out into the health problems caused by front-end waste, commonly called mine tailings. These substantial amounts of waste contained uranium when mined and could be a source of harm.

Reports on this research are published regularly.

SOME MAJOR EVENTS

-- Following the breakdown of a nuclear plant at Three Mile Island in the United States, a Select Committee on Ontario Hydro Affairs issued a report on the safety of the CANDU reactor used in Canada. The report found the level of safety applied at operating plants was satisfactory, but made 20 recommendations including further study of the CANDU system.

-- Further exploration and evaluation was carried out at Key Lake, Saskatchewan, by Key Lake Mining Corporation. Partners in this joint venture are Saskatchewan Mining Development Corporation, and Eldor Resources Limited, a wholly-owned subsidiary of Eldorado Nuclear Limited. The company hopes to be in production at the rate of 3 080 to 4 600 tonnes of uranium per year by 1983.

-- Publication of airborne radiometric survey results for an area of 75 000 square kilometres in northeastern Ontario marked the completion of three years' work under the Federal-Provincial Uranium Reconnaissance Program. During the course of the program, airborne radiometric and geochemical surveys to map the distribution of uranium and associated elements were undertaken in all provinces and territories of Canada. The major participants were the federal government, British Columbia, Saskatchewan, Manitoba, Ontario, New Brunswick and Newfoundland. In total 860 000 square kilometres were covered by geochemical surveys and 1 590 000 square kilometres by radiometric surveys. As a result of the program, industry has staked thousands of claims and initiated exploration costing, in total, millions of dollars. Most of the surveys carried out under the Uranium Reconnaissance Program were conducted by Canadian contractors.

-- The Federal Court ruled in November 1979, that aboriginal title permitted the Inuit to hunt and fish over an area covering 130 000 square kilometres around Baker Lake. The court decided that surface rights were not included, however, and lifted a temporary injunction against further uranium exploration in the Baker Lake area on December 17, 1979. Restricted land use permits are held by a number of exploration companies. The restricted areas include land used for caribou migration, calving and post-calving assembly, as well as critical wildfowl resting and moulting areas.

RENEWABLE ENERGY

While hydro-electricity remains the major renewable energy resource currently developed, the federal government's $380 million, five-year program of support to projects developing renewable energy and conservation technologies will accelerate the adoption of these alternatives.

BIOMASS

Much progress has been made in the use of biomass, such as agricultural and forestry wastes, as a renewable energy source. Biomass can be burned to provide energy or converted into liquid or gaseous fuels through fermentation.

Canada's forest industry generates vast quantities of combustible residue, such as sawdust, bark and tree branches. The use of this resource has been stimulated by the government's Forest Industry Renewable Energy Program (FIRE). This program helps finance conversion of existing facilities or the installation of new facilities that use this energy resource. By the end of 1979, projects valued at more than $35 million had been initiated, with federal assistance providing some $6.5 million or 20 per cent towards the capital costs. The approved projects will ultimately save more than 160 000 cubic metres of oil each year.

In the long-term, up to 16 million cubic metres of oil a year could be saved by tapping the energy potential of the forest industry waste. There is a substantial increase in the program of federal research and development into the production, harvesting and conversion of forest resources. Through the "Energy-from-Forests" Research, Development and Demonstration program, approximately $40 million will be available to help fund research projects and demonstrations of innovative biomass-related technologies over the next five years.

SOLAR HEATING

The potential for solar heating is great, as about one-third of Canada's energy demand is for low-grade heat below 100°C. Some of this demand could be met by solar and make an important contribution to Canada's goal of self-sufficiency in energy. Enough energy from the sun reaches the earth each day to meet our enegy needs 3 000 times over, but it is widely diffused and unavailable at night or during cloudy weather. It can be difficult and costly to find effective ways to put this energy to work.

Since the first Canadian solar-heating system was built in 1971 by Erich Hoffman in Surrey, British Columbia, other private enthusiasts, companies and federal and provincial governments have built hundreds of systems to investigate the potential.

About 32 per cent of Canada's energy demand is in the form of low-grade heat below 100°C, the majority for water space heating, industrial, residential and agricultural applications.

Swimming-pool heating by some methods is already competitive with other fuels. The low temperatures and the inexpensive solar equipment required to raise the water temperature only 5-10°C have made this the largest application of solar energy to date.

Water heating for domestic, industrial and commercial applications seems to have a large potential as conventional fuel costs rise and solar heating equipment becomes more competitive. In parts of the country where fuel costs are high, some applications may already be competitive.

Space heating of buildings - unlike pool heating or water heating in summertime, which use solar energy when it is readily available - is most needed at the time when solar energy is at a minimum. This means that some of the more complex "active" space heating systems will not be as economical as quickly as pool or water heating systems. Fortunately, however, new energy-sufficient homes can capture solar energy directly through windows that face south or in walls designed to store the sun's energy. These systems add cost to a building but can reduce the requirement for conventional fuels.

Process heat for industrial and agricultural applications is also a possible large market for solar energy. There is a need for year-round supplies of low, medium and high-temperature heat for a wide variety of applications.

To date, federal efforts have concentrated on the creation of an unsubsidized Canadian solar industry and the development of cost-effective, reliable solar systems that meet standards which will protect the purchasers of solar heating equipment.

There are significant market opportunities for solar and the potential to create many new jobs, but many matters have yet to be resolved, among them:

-- more development to make solar heating more competitive with other alternatives;

-- appropriate standards and warrantees to ensure the equipment will stand up to the Canadian climate;

-- guaranteeing consumers access to sunlight for their solar collectors;

-- appropriate standards for the installation and maintenance of equipment to protect consumers and ensure reliable operation;

-- reducing financial barriers to purchasing equipment;

-- reducing penalties to consumers - such as property taxes that may increase with solar installations or high fuel costs for supplementary heating;

-- the acceptance of life-cycle costing, the concept that high capital costs for solar systems will be offset by decreased fuel-costs over the lifetime of the equipment.

The federal government has a range of programs designed to develop and evaluated the potential of solar energy.

Federal government activities in support of solar research and development include:

-- the provision of over $11.5 million for research and development of solar energy by the National Research Council in the period 1979-80;

-- Program of Assistance to Solar Equipment Manufacturers (PASEM). Initially 24 contracts of up to $10 000 each were awarded to firms to prepare submissions for solar development. The program, administered by the Department of Public Works awarded ten cost-share contracts (federal share of up to $300 000 each) to develop solar heating components, solar systems, as well as production and marketing capabilities;

-- Purchase and Use of Solar Heating (PUSH).
A $125 million program that guarantees a market for five years for a new solar industry through the purchase of solar equipment for federal government buildings. The program, also administered by the Department of Public Works will allow the industry an opportunity to gain experience and solve problems associated with emerging technologies.

-- Low Energy Building Design Awards (LEBDA).
A program that recognizes and encourages energy-efficient design of commercial, institutional and light industrial buildings. Prizes were awarded for existing buildings totalled $80 000, while $170 000 was available for new designs.

-- the demonstration of some novel solar technologies and projects may be financed through federal-provincial demonstration programs administered by Energy, Mines and Resources Canada. The federal contribution to these cost-sharing agreements is $114 million dollars over five years.

Solar equipment performance standards are being developed under National Research Council contract by the Canadian Standards Association. The NRC is expanding its program on the development of prototype systems suitable for mass production by industry.

GEOTHERMAL

Although it is clearly a long-term prospect, buried hot water and rocks provide Canada with considerable energy potential.

These geothermal energy resources are in two different areas. Some localities of the Prairies cover sedimentary rocks containing water at about 80°C. An experiment at the University of Regina intends to use this subsurface water with heat exchangers to provide space heating.

The second area containing geothermal energy potential is the Rocky Mountains, where volcanic action brings rock temperatures into the 100° - 300°C range within accessible drilling depths. Surveys are under way to locate and assess the geothermal potential of these localities. The federal government and British Columbia Hydro are drilling at Meager Mountain, north of Vancouver, to assess the feasibility of constructing a geothermal electric power station.

WIND

Wind has been used as an energy source for generations, but much research remains to be done before wind-driven generating stations will be economical and practical on a large scale.

Work by the National Research Council, in collaboration with provincial utilities and engineering companies, has given Canada a lead in the development of the vertical-axis wind turbine, which employs an "egg beater" rotor configuration.

During 1978-79, two 50-kilowatt machines were in operation - one at Holyrood, Newfoundland, and the other at Swift Current, Saskatchewan - to test mechanical and electrical components. Similar test installations are planned for British Columbia, Manitoba and Ontario.

The largest machine in operation is the 230-kilowatt wind-turbine generator jointly run by the NRC and Hydro-Quebec on the Magdalen Islands. It is fully automatic and connected to the island's 36-megawatt generation system. In 1978 an industry group, under NRC contract, calculated favourable cost estimates for similar but larger machines in the megawatt power range. A proposal to construct a prototype of this size is being considered.

A small grid-coupled wind turbine operates at Rideau Falls in Ottawa as part of a public demonstration of renewable energy resources.

TIDAL POWER

Harnessing the massive power of the Bay of Fundy tides to generate electricity moved a step closer to reality during the year.

A low-head hydro tidal power demonstration plant will be constructed in the Annapolis Basin in a $46 million project involving the government of Nova Scotia, the federal government and the Nova Scotia Tidal Power Corporation.

The plant, to be on stream by 1983, will produce 50 million kilowatt-hours annually. It will test a new hydro-electric turbine which could eventually provide economic development of hydro sites in other parts of Canada, as well as major sources of tidal power, including the Bay of Fundy.

The concept, developed in Switzerland, has not yet been demonstrated on a scale that would make it suitable for the larger generation unit sizes necessary in major tidal developments. Smaller units have been employed in Europe, but the opportunities for larger installations appear more attractive in Canada.

The demonstration plant provides a short term benefit also: it will, with its output of electrical power, displace a small amount of oil.

SOME MAJOR EVENTS

-- The Department of Agriculture is supporting studies on fermentation of agricultural wastes. This process produces methane gas for fuel, leaving a residue which is useful fertilizer. High rates of methane production are theoretically possible but are not achieved in practice because of technical difficulties. Two farm-scale digesters have been operated successfully on hog manure.

-- The Department of Agriculture is also studying the production of fuels by heating in the absence of oxygen. It is determining the yields of gaseous and liquid products, such as methyl alcohol, from various farm wastes. The gases produced can be used to fuel internal combustion engines. Various gasifier designs are being tested, including fluidized-bed systems.

-- The Department of Energy, Mines and Resources is supporting work on a prototype reactor which is being developed at a British Columbia lumber mill to produce wood-gas as a fuel for its drying kilns. The department is also operating a small 20-kilowatt mobile gasifier to evaluate its potential use on farms.

-- Etco Photo Ltd. of Lasalle, Quebec, introduced an important solar development in Canada by using more than 420 solar collectors to heat 81 000 litres of water required daily for the firm's processing. Canada's largest solar installation, on a clear summer day it can meet the daily 2 500-kilowatt hot water requirement of Etco Photo.

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CONVERSION FACTORS

The data presented in Energy Update 1979 are in metric units. For readers who wish to know the approximate equivalents in Imperial or other common units, the following table may be of assistance.

metric unit	equivalent (approximate)
1 metre	3.28 feet
1 kilometre	0.62 mile
1 square kilometre	0.39 square mile
1 litre	0.22 Imperial gallon
1 cubic metre (oil)	220 Imperial gallons 6.29 American barrels
1 cubic metre (natural gas)	35.3 cubic feet
1 kilogram	2.2 pounds
1 metric tonne	1.1 short tons 0.98 long tons